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RECENT PROGRESS IN ASTRONOMY.

It is impossible in this place to give any adequate account of recent astronomical papers of a mathematical character. Hence it is sought simply to submit brief analyses of some of the more generally interesting memoirs which have been published within the last few months. Even the list of these can not be made complete.

Decidedly the most important recent contribution of observing astronomy is the "Uranometria Argentina"* of Dr. Gould. This is the first astronomical publication of the National Observatory of the Argentine Republic.

One of the first objects of Dr. Gould, on the establishment of the new observatory in 1870, was the making of a uranometry of the southern sky which should contain the position and magnitude of every star visible to the naked eye at his station.

The model on which it is made is the celebrated "Uranometria nova" of Argelander, of Bonn, which was published in 1843. This latter contains 3,256 stars, from the first to the sixth magnitude, which are to be seen above the horizon of Bonn. Its magnitudes are expressed in *thirds* of a whole magnitude, and Argelander's scale, so established, has served for a standard in all observations in the northern hemisphere. Dr. Gould's problem was to extend this enumeration over the whole southern sky, keeping accurately to the standard set by Argelander. This is by no means an easy task, as the *minimum visibile* at Cordoba was found to be not the 6.0 magnitude, but 7.1; that is, stars can still be seen at Cordoba which have less than four tenths of the light of the faintest of Argelander's stars. This extraordinary transparency of the atmosphere required the extension of Argelander's scale downward, and that this was accomplished successfully is shown by a comparison of the

* "Resultados del Observatorio Nacional Argentino." Vol. i, "Uranometria Argentina," Buenos Aires, 1879, 4to, with Atlas.

magnitudes of all the stars which are common to the two uranometries. The mean difference is rather less than one tenth of a magnitude. The method of settling the standard was to select from the "*Uranometria nova*" a belt of stars which had the same altitude at Bonn and at Cordoba. The 722 stars of this belt were observed by the four assistants at the southern observatory (Messrs. Rock, Thome, Davis, and Hathaway), and those stars for which their estimated magnitudes were precisely the same were chosen for standards. Thus, a number of stars of each magnitude as 3.00, 3.33, 3.66, 4.00, 4.33, etc., became types to be constantly referred to. From these types a number of others in a zone near the south pole (and hence constantly visible) were constructed. The process of observation consisted in referring each star in the heavens to this set of types, so that its magnitude could finally be determined upon. This was done by the four observers independently, but often in duplicate, and so well were the standards fixed that each observer's comparisons differed from the mean of all four by quantities very much less than a tenth of a magnitude. It should be said that the magnitudes in the southern uranometry are given to tenths.

In all, there are 10,649 stars visible to the naked eye at Cordoba. Of these, 8,198 are as bright or brighter than the 7.0 magnitude, and these alone are given in the catalogue and in the maps. Of these 10,000 stars, more than 46,000 observations were made. In the progress of the work quite a number of variable stars were detected, of each of which a full history is given in the notes. Indeed, Dr. Gould's firm conviction is, that "stellar variability is by no means an exceptional phenomenon, but that at least one half of the stars above the 7.0 magnitude vary by amounts which careful observation can not fail to detect."

An atlas of fourteen charts accompanies the catalogue, and gives an exact pictorial representation of the state of the sky at the epoch of the work. Besides giving a representation of the isolated stars, the shadings and gradations of the milky way are given with the greatest detail from repeated observations and revisions. By no means the least valuable part of the work is the discussion of the course of the milky way throughout the whole sky. The course of the galaxy is now, and only now, known with precision. The data of this and preceding uranometries are discussed by Dr. Gould with reference to the question of the distribution of the stars in space, starting from the assumption that, on the whole, stars are equally scattered. Dr. Gould finds that there is a marked excess

of the stars from the first to the fourth magnitude. Furthermore, he finds that there is in the sky a zone or belt of bright stars as marked as the milky way, and that all the bright stars are distributed more symmetrically with respect to this belt than with regard to the milky way itself.

From these facts Dr. Gould concludes that "our own solar system forms a part of a small cluster distinct from the vast organization of that which forms the milky way." This cluster may perhaps be comparable with that of the Pleiades, since by a rough estimate it would seem to consist of about 500 stars. It is situated nearly in the plane of the belt of bright stars.

No more valuable work than this has been given to astronomy within a decade; and it will be a source of pride to Americans to find such important contributions coming from one of their countrymen in the southern hemisphere, with which the name of Gilliss was already indissolubly associated.

There are no marks about the work itself which would show that it was done in a community in about the state of Europe during the dark ages, and it will add not to the value of the work but to the credit of the workers if one remembers that this is strictly the case.

It has long been known to students of the philosophical writings of Emmanuel Swedenborg that he was the author of an elaborate theory of the origin of the solar and stellar system, which was the prototype of those now received. The facts in the case are briefly these: In his "*Principia*," published in 1734, a complete system of cosmogony was proposed in which the genesis of the planets and satellites from a primitive nebulous mass was maintained. The details of the processes imagined are given and illustrated with drawings in the fullest manner. Its resemblances and differences with the nebular hypothesis of Laplace we shall consider later. The question is now one of history. Laplace, in announcing his own theory in the "*Exposition du Système du Monde*" (1809), (note vii), quotes the theory of Buffon (1749), introducing it by the phrase "*Buffon est le seul que je connaisse, qui, depuis la découverte du vrai système du monde, ait essayé de remonter à l'origine des planètes et des satellites.*" A large part of this memorable note is given up to the refutation of Buffon's theory, which, though ill grounded according to Laplace, still serves as a point of departure for him, and without which the nebular hypothesis, as we know it, might not have had an existence. In the original statement of his own

theory Buffon gave no hint that he was acquainted with any previous one, but a mere chance has given us light on this question.

Mr. Bohn, the celebrated publisher of London, had in his possession about 1840 a copy of Swedenborg's "*Principia*," containing Buffon's own autograph, and bearing the marks of use. There is no doubt, when the essential points of the three systems are considered, that the suggestions of the system of Swedenborg (published fifteen years before Buffon's) influenced Buffon largely, and that the ideas of Buffon, together with the reflections on the construction of the heavens by the elder Herschel, led Laplace to the final form of his nebular hypothesis.

To complete the historical portion of this sketch, it should be said that Kant published his "*Theorie des Himmels*" in 1755, twenty-one years after the "*Principia*," but probably without obligation to it. While these facts have long been known to students of Swedenborg, they have been generally ignored by astronomers until the publication of M. Nyrén's notice on the subject.*

The theory of Swedenborg is too elaborate to be fully stated here. The essential points of it are given by M. Nyrén. A few extracts from Swedenborg's own work, in addition to those given by M. Nyrén, may better illustrate his position. He is a believer in vortices, not exactly like those of Descartes, but there is no ambiguity in his description of them: "The magnetic sphere, with its vortices, is a type and small effigy of the starry heaven. . . . Every particle of the magnetic element spontaneously endeavors to enter into a vortical motion, if there be only an active center round which it can gyrate. . . . There may be as many spiral vortices as there are active centers. . . . The sun [and each star] is an active center. . . . All things are similar to one another: . . . in the sphere of the magnet there are spiral vortices, in like manner in the sidereal heavens. . . . The second elementary particles are most highly compressed near the solar active space. . . . In this manner the number and quantity more and more increase, by reason of the successive compression of the elementaries, and also condense themselves round the solar space. The finites thus concrete into an immense volume, and crowd around and inclose the sun in such a manner as to form an incrustation. . . . Nevertheless, this crust which is formed around the sun is rotated in a certain gyre. . . . This crustaceous matter, being endowed with a continual gyratory

* "*Ueber die von Emmanuel Swedenborg's aufgestellte Kosmogonie.*" M. Nyrén, "*Vierteljahrsschrift der Astron. Gesell.*" Bd. 14.

motion round the sun, in the course of time removes itself farther and farther from the active space ; and, in so removing itself, occupies a larger circle of space, and consequently becomes gradually attenuated till it can no longer contiguously cohere, but bursts in some part or other. . . . The solar crust being somewhere disrupted on the admission of the vortical volume, collapses upon itself, and this toward the zodiacal circle of the vortex, so that it surrounds the sun like a belt or broad circle. This belt, which is formed by the collapse of the crustaceous expanse, gyrates in a like manner ; removes itself to a farther distance ; and, by its removal, becomes attenuated till it bursts and forms into larger and smaller globes ; that is to say, forms planets and satellites of various dimensions, but of a spherical figure."

All these successive stages are, in Swedenborg's original, accompanied with woodcuts which make his imagined processes plainer, and do away, in some manner, with the repulsive nomenclature which he adopted, and which can not be explained here.

An examination of the two systems of Laplace and Swedenborg leads to the result that one is the exact converse of the other. With Laplace, there is a primitive nebula, which in shrinking abandons rings of matter. These consolidate into planets. With Swedenborg, the rings or zones are thrown off from the sun in a tolerably solid condition ; and they contain, when thrown off, spherical masses in an advanced state of consolidation. Laplace's evolution takes place in order from the circumference to the center, so that the stuff of which the outer planets is made has the longest existed separate from the sun. With Swedenborg, it is the reverse. The recent researches of Mr. George Darwin on the evolution of the moon are most interesting in this connection. According to the results of a series of papers lately delivered to the Royal Society, the moon was primitively a solidifying body closely attached to the sphere of the earth—even touching it—and revolving with the earth in a few hours in the plane of its equator. As time went on, the variations in the time of revolution, in the inclination of the orbit, etc., took place until the present state was reached. If we must accept Mr. Darwin's late conclusions, it appears that they cohere much better with the hypothesis of Swedenborg than with that of Laplace ; and this fact, no less than the historical interest attaching to the origin of the nebular hypothesis, makes M. Nyrén's paper of importance.

For some years it has been generally received that the star *a*

Ursæ Majoris periodically changed its color from yellow through red to orange, etc., every thirty-two days. This supposed discovery was made in 1867 by Klein, and has been confirmed or at least not disproved by several subsequent observers.

The question is now tolerably well settled through a series of observations by Sáfarik,* who has chosen three other stars to observe simultaneously with this. He has shown that the variations in α Ursæ are no greater than in the case of these three stars, which are pretty certainly constant in color, and he gives it as his opinion that α Ursæ must be considered also as of a constant color unless we are willing to admit that all stars are variable in tint in short periods of time. This result is of more importance than at first sight appears, as we have now no well-authenticated case of variation in color separate from variation in brilliance.

Dr. Gyldén,† of Stockholm, has recently published a mathematical investigation in which he shows the possibility of explaining the observed variation in the light of stars upon pure mechanical principles. He takes as a basis the idea that the surfaces of such stars are covered in parts with a kind of crust or *slag* which gives out less light than the remaining parts of the surface which are glowing. Further, he supposes these stars to be rotating on their axes, and he shows that such a rotation will account for all the phenomena, particularly as the axis of rotation will itself be changed from time to time by the different disposition of the floating masses on the surface.

The Harvard College Observatory ‡ has continued its researches on the photometry of stars and planets, and has published several important volumes on this subject within a few years. The results of these can not be given here, but a plan now in operation there should be described. Professor Pickering proposes to determine the relative amount of light of all stars visible at Cambridge, and has devised a most ingenious and effective piece of apparatus for the purpose.

This is an horizontal telescope which is directed to the west, and has two objectives. In front of each is a reflector. By means of

* "Ueber den Farbenwechsel von α Ursæ Majoris, von A. Sáfarik." Vierteljahrsschrift der Astron. Gesell. 1879. Pp. 367.

† H. Gyldén: "Versuch einer mathematischen Theorie zur Erklärung des Lichtwechsels der veränderlichen Sterne." 4to. Helsingfors, 1880.

‡ Harvard College Observatory: "Report of the Committee of the Overseers," etc. Cambridge, 1879. 8vo.

one of these the pole-star is constantly kept in the field of view as a standard of reference, while by means of the other any star on the meridian may be compared with it. To determine the effect of atmospheric absorption, a special list of circumpolar stars is being observed. In this way Professor Pickering intends to compare every star visible at Cambridge with Polaris, and thus to make an accurate photometry of more than three fourths of the heavens.

The whole subject of the nature of the phenomena of solar eclipses is in so undecided a state that even those who are most familiar with it are conscious of their incomplete knowledge of the data. A general review of the evidence on special points has been wellnigh impossible. Like all comparatively new problems, the different branches of the research have been developed in quite an irregular way. On some lines of research our knowledge is very considerable; on others, we have scarcely any trustworthy information.

This was specially a hindrance in the study of the phenomena of solar eclipses, because it is just here that we may hope for striking advances within a few years. And it is necessary, in order to plan our future work, to know what has already been settled, and along what lines of study results are to be sought. A recent publication of Mr. Ranyard's,* on the phenomena of "Solar Eclipses," is intended to meet these difficulties. Mr. Ranyard has collected in Volume XLI of the "*Memoirs of the Royal Astronomical Society*" (792 pages, 18 plates, and a great number of woodcuts) all the accounts of solar eclipses which have been published from the earliest times up to 1878.

Each account is cut up into parts, as it were, and the matter of each part is inserted in its proper chronological order, under one of forty-four headings, chosen by Mr. Ranyard with great care. Each heading constitutes a chapter, and the chapters are arranged about in the order in which the phenomena of which they treat occur. Thus, the chapters relating to the phenomena near first contact have for titles: Chapter VII. "The Cusps of the Solar Crescent seen as colored"; Chapter VIII. "The Moon seen as red before Totality"; Chapter IX. "Shadow-Bands"; etc., etc. Perhaps the most important chapters are numbered XLI, XLII, XLIII, XLIV: On "The Brightness of the Corona," on "Polaroscopic and Spec-

* *Memoirs of the Royal Astronomical Society*, vol. xli. "Observations during Solar Eclipses," by A. C. Ranyard. London, 1879. 4to.

troscopic Observations," and on "Photographs and Drawings of the Corona," respectively. The last chapter consists of 238 pages, and contains a reproduction of every important modern drawing. A very good feature of the woodcuts is that the axis of the sun is made vertical on the page, and the sun's vertex is marked also. The plates relate to the spectrum of the corona, etc., and to the photographs, etc., of the total phase. We are glad to notice that due credit is here given to Dr. Busch, who first took a daguerreotype of the corona in 1851, at Königsberg. The very varied material contained in the volume is made available by an elaborate subject and author index, and the chief problems which Mr. Ranyard set to himself are resolved. These were : 1. To give in the order of time all the important observations on each of the main topics of study ; 2. To enable the work of any particular individual to be examined ; and, 3. To enable each solar eclipse to be studied by itself if desired.

The work has required about nine years for its preparation, and is practically complete. We have simply to add to the data there given, and need never go back of it. In general, there is no complete discussion of the results to be derived from each chapter, and this reserve seems wise. In some cases the necessary conclusions are pointed out, always, it seems, with moderation. It is an unfortunate consequence of this kind of semi-bibliographical work that it will be severely criticised. Each chapter will appear inadequate to the specialist in the subject of which it treats. There can be no doubt but that Mr. Ranyard has succeeded in his most difficult task, and that this publication will forward the solution of the most important questions involved, in a very marked way. The work comes at exactly the right time, and satisfactorily fills its place.

The three periodic comets whose orbits have been the most carefully investigated are Encke's, Winnecke's, and Faye's. Their least distances from the sun are $\frac{34}{100}$, $\frac{78}{100}$, $\frac{169}{100}$ of the earth's distance respectively. It is well known that Encke's original researches indicated the existence of a resisting medium in space which, by opposing the motion of the comet through it, gradually shortened its period of revolution. All of Encke's computations were repeated by Dr. von Asten, and his general results confirmed. Dr. Möller, of Lund, executed a like work for Faye's comet, and found no such change in its period, and the conclusion was that, granting the existence of a resisting medium, it did not extend so far as one and a

half times the earth's mean distance. Dr. Oppolzer has just concluded a similar investigation for Winnecke's comet.* He finds that its motion is altered in the same way as that of Encke's comet, and the value of the resisting force is found to be almost the same as that found by Encke. Dr. Oppolzer goes further, and shows that, granting the existence of such a resisting force, its effect upon the motion of Faye's comet would be so small as to be confounded with uncertainties of the computed perturbations. The existence of the resisting medium is now rendered quite probable. The question will be definitively settled by computations now in progress upon the other comets of short period.

The buildings for the new observatory of the University of Strasburg† have been completed, and a description and plates of them made by the director, Dr. Winnecke. The principal instruments are :

1. A meridian circle by Repsold ; aperture 162 mm. (6·4 inches).
2. An altazimuth by Repsold ; aperture 136 mm. (5·4 inches).
3. A refractor by Merz ; aperture 487 mm. (20·2 inches).
4. An orbit-sweeper by Repsold ; aperture 163 mm. (6·4 inches).

There are three buildings—one large one, containing the residences of the astronomers, and two smaller.

On the main building is the large iron dome, some thirty-nine feet in diameter. There are two novelties in its construction : First, the shutters to the dome are made in two parts and extend from horizon to horizon. They are opened symmetrically by screws, and leave the whole 180° open at once. Secondly, the dome, which weighs about ninety thousand pounds, is turned by means of heavy weights which are wound up from time to time as required. A touch from the observer will release these, and their fall will turn the dome right or left as required. The working of this dome will be attentively regarded, as most of the difficulties of such structures appear to have been successfully avoided.

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* *Astronomische Nachrichten*.

† "Die neue Strassburger Universitäts Sternwarte, von A. Winnecke, *Vierteljahrsschrift der Astron. Gesell.*" 1879, p. 328.